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TECHNICAL OPERATIONS RESEARCH

CATALOGED BY DDC
AS AD No. 439633

Shelter Research 1100
Protection Studies
Subtask 1111A

SUMMARY
OF
RESEARCH REPORT

PROTECTION FACTORS OF EMERGENCY SHELTERS
IN A BRITISH RESIDENCE

November, 1963

This is a summary of a report which has been reviewed in the Office of Civil Defense and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Office of Civil Defense.

MAY 1964

OCD-OS-62-14

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February, 1964

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SUMMARY

BACKGROUND

Early in 1962, the British Home Office requested the cooperation of the U.S. Office of Civil Defense in conducting full-scale and model experiments to verify the British procedure for the computation of fallout protection offered by residential structures. The OCD welcomed the opportunity to participate, since the tests would allow further evaluation of the U.S. radiation modeling technique, and the results of the comparison between test data and computation results using both British and U.S. techniques would be of interest to the U.S. civil defense effort.

EXPERIMENT PLAN

FULL-SCALE HOUSE

The British selected for test in the U.K. a typical, two-story duplex residence, symmetrical on both sides of a center partition and with exterior walls of 100-psf thickness. This structure was set in a typical neighborhood; that is, it was surrounded by other similar dwellings.

SCALE MODEL HOUSE

Theoretically, the gamma radiation within a structure from radiation sources outside that structure will be reproduced in a geometrically similar model if the densities of all materials comprising the structure, the surrounding ground, and the atmosphere are increased by the geometric scale factor. Although it is not possible to increase densities by a factor large enough to be useful in reducing building dimensions, compromises in the choice of materials and in relative wall thicknesses will still permit fairly accurate work at practical scales. For this series of tests, a scaling factor of 12 was chosen and the building materials were modeled in steel.

Because of a misinterpretation of initial information, the first series of tests was run on a model with 50-psf exterior and interior walls instead of the 50 psf interior walls and 100 psf exterior walls of the full-scale house. Another model duplicating the wall thickness of the full-scale house was later built and tested.

To approximate the sloping lot on which the full-scale house was built, the models were tilted to an equivalent angle. To eliminate ground penetration, the model was placed on a 2-in. thick lead slab, covered with a 1/2 in. thick steel plate. The average mass density of the surrounding houses was found to equal that of solid concrete and, hence, in the model experiments, the surrounding houses were represented by solid concrete blocks stacked to the appropriate size.

FALLOUT SHELTERS

Four sandbag emergency shelter designs were tested for radiation attenuation in both the full-scale and model structures: a simple lean-to shelter placed against the wall of the sitting room at 60° to the ground with a mass thickness of 65 psf; a 65 psf A-frame shelter at angles of 60° in the center of the sitting room with both ends open and with a 65 psf baffle at one end; a rectangular shelter in the center of the sitting room with varying wall and roof thicknesses

120 psf walls	{ 25 psf roof
	{ 50 psf roof
75 psf walls	{ 35 psf roof
	{ 70 psf roof

and an under-the-stairs shelter with wall thicknesses of 64 psf and 76 psf.

Measurements were made on both the model and full-scale structures with and without shelters installed.

RADIATION SOURCE

A uniform density of contamination surrounding the structures was simulated by pumping a 100-curie cobalt-60 source through polyethylene tubing arranged in two annuli around the full-scale house to a maximum radius of 120 ft, and a 20-curie source in a spiral configuration around the model house to a radius of 10 ft.

INSTRUMENTATION

Dosimeters were evenly spaced in two vertical planes across the width of one half of the first floor of each structure. One series of dosimeters provided horizontal traverses through the center of the living room and sitting room at heights

of 1, 2, and 4 ft above the floor. Another series provided horizontal traverses across the kitchen and stairwell at a full-scale distance of 18 in.

RESULTS

Three series of tests were run:

Model (50 psf exterior walls)	March 18 - April 4, 1963
Full Scale (100 psf exterior walls)	May 9 - June 1, 1963
Model (100 psf exterior walls)	August 19 - September 6, 1963

The data were compared with calculations using the OCD Engineering Manual and with the results of British computations. This comparison is summarized in the following table in terms of the protection factor, or ratio of dose rate in the location cited to the dose rate 3 ft in air above an infinite ground plane contaminated to the same density of activity.

Structure	Calculated		Experimental	
	U.K.	U.S.	Full Scale	Model
Empty house	16	17	21	18
Lean-to shelter	32	29	39	34
A-frame shelter	49	43	44	47
A-frame shelter with end baffle	68	58	61	63
Rectangular shelter 120 psf wall, 50 psf roof	83	94	53	93
Stairway shelter with 1 wall baffle	29	26	24	25
Stairway shelter with 3 wall baffles	54	46	47	41